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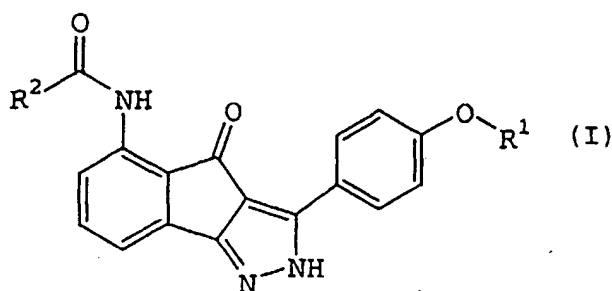
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- (71) Applicant (for all designated States except US): **BRISTOL-MYERS SQUIBB PHARMA COMPANY** [US/US]; Route 206 and Province Line Road, Princeton, NJ 08543-4000 (US).
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- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **CARINI, David, J.** [US/US]; Wilmington, DE 19898 (US).
- (74) Agent: **HALSTEAD, David, P.**; Ropes & Gray, One International Place, Boston, MA 02110-2624 (US).
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(54) Title: SEMICARBAZIDES AND THEIR USES



(57) Abstract: The present invention relates to the synthesis of a new class of 5-substituted-3-(4-OR¹-phenyl)-2H-indeno[1,2-c]pyrazol-4-ones of formula (I): formula (I) that are potent inhibitors of the class of enzymes known as cyclin dependent kinases, which relate to the catalytic subunits cdk1-7 and their regulatory subunits known as cyclins A-G. This invention also provides a novel method of treating cancer or other proliferative diseases by administering a therapeutically effective amount of one of these compounds or a pharmaceutically acceptable salt form thereof. Alternatively, one can treat cancer or other proliferative diseases

by administering a therapeutically effective combination of one of the compounds of the present invention and one or more other known anti-cancer or anti-proliferative agents.

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TITLE

Semicarbazides and Their Uses

FIELD OF THE INVENTION

This invention relates generally to novel 5-substituted-3-(4-OR¹-phenyl)-2H-indeno[1,2-c]pyrazol-4-ones which are useful as cyclin dependent kinase (cdk) inhibitors, pharmaceutical compositions comprising the same, methods for using the same for treating proliferative diseases, and intermediates and processes for making the same.

BACKGROUND OF THE INVENTION

One of the most important and fundamental processes in biology is the division of cells mediated by the cell cycle. This process ensures the controlled production of subsequent generations of cells with defined biological function. It is a highly regulated phenomenon and responds to a diverse set of cellular signals both within the cell and from external sources. A complex network of tumor promoting and suppressing gene products are key components of this cellular signaling process. Overexpression of the tumor promoting components or the subsequent loss of the tumor suppressing products will lead to unregulated cellular proliferation and the generation of tumors (Pardee, Science 246:603-608, 1989).

Cyclin dependent kinases (cdks) play a key role in regulating the cell cycle machinery. Cdk complexes consist of two components: a catalytic subunit (the kinase) and a regulatory subunit (the cyclin). To date, nine kinase subunits (cdk 1-9) have been identified along with several regulatory subunits (cyclins A-H) (A.M. Senderowicz and E.A.

5 Sausville Journal of the National Cancer Institute (2000),
92 (5), 376-387; and S. Mani; C. Wang; K. Wu; R. Francis; R.
Pestell Exp. Opin. Invest. Drugs (2000) 9(8), 1849-1870).
Each kinase associates with a specific regulatory partner
and together make up the active catalytic moiety. Each
10' transition of the cell cycle is regulated by a particular
cdk complex: G1/S by cdk2/cyclin E, cdk4/cyclin D1 and
cdk6/cyclinD2; S/G2 by cdk2/cyclin A and cdk1/cyclin A; G2/M
by cdk1/B. The coordinated activity of these kinases guides
the individual cells through the replication process and
15 ensures the vitality of each subsequent generation (Sherr,
Cell 73:1059-1065, 1993; Draetta, Trends Biochem. Sci.
15:378-382, 1990)

An increasing body of evidence has shown a link between
tumor development and cdk related malfunctions. Over
20 expression of the cyclin regulatory proteins and subsequent
kinase hyperactivity have been linked to several types of
cancers (Jiang, Proc. Natl. Acad. Sci. USA 90:9026-9030,
1993; Wang, Nature 343:555-557, 1990). More recently,
endogenous, highly specific protein inhibitors of cdks were
25 found to have a major effect on cellular proliferation (Kamb
et al, Science 264:436-440, 1994; Beach, Nature 336:701-704,
1993). These inhibitors include p16^{INK4} (an inhibitor of
cdk4/D1), p21^{CIP1} (a general cdk inhibitor), and p27^{KIP1} (a
specific cdk2/E inhibitor). A recent crystal structure of
30 p27 bound to cdk2/A revealed how these proteins effectively
inhibit the kinase activity through multiple interactions
with the cdk complex (Pavletich, Nature 382:325-331, 1996).
These proteins help to regulate the cell cycle through
specific interactions with their corresponding cdk
35 complexes. Cells deficient in these inhibitors are prone to
unregulated growth and tumor formation.

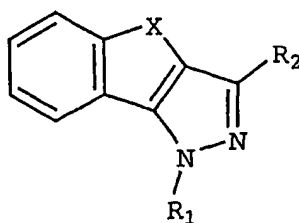
5 Protein kinases, in particular, cdk, play a role in the regulation of cellular proliferation. Therefore, cdk inhibitors can be useful in the treatment of cell proliferative disorders such as cancer, familial adenomatosis polyposis, neuro-fibromatosis, psoriasis, 10 fungal infections, endotoxic shock, trasplantaion rejection, vascular smooth cell proliferation associated with atherosclerosis, pulmonary fibrosis, arthritis glomerulonephritis and post-surgical stenosis and restenosis (U.S. Patent No. 6,114,365). Cdk's are also known to play a 15 role in apoptosis. Therefore cdk inhibitors, could be useful in the treatment of cancer; viral infections, for example, herpevirus, poxvirus, Epstein-Barr virus, Sindbis virus and adenovirus; prevention of AIDS development in HIV-infected individuals; autoimmune diseases, for example, 20 systemic lupus, erythematosus, autoimmune mediated glomerulonephritis, rheumatoid arthritis, psoriasis, inflammatory bowel disease, and autoimmune diabetes mellitus; neurodegenerative disorders, for example, Alzheimer's disease, AIDS-related dementia, Parkinson's 25 disease, amyotrophic lateral sclerosis, retinitis pigmentosa, spinal muscular atrophy and cerebellar degeneration; myelodysplastic syndromes, aplastic anemia, ischemic injury associated with myocardial infarctions, stroke and reperfusion injury, arrhythmia, atherosclerosis, 30 toxin-induced or alcohol related liver diseases, hematological diseases, for example, chronic anemia and aplastic anemia; degenerative diseases of the musculoskeletal system, for example, osteoporosis and arthritis, aspirin-sensitive rhinosinusitis, cystic 35 fibrosis, multiple sclerosis, kidney diseases and cancer pain (U.S. Patent No. 6,107,305).

5 It has also been discovered that some cyclin-dependent
kinase inhibitors can be used in combination therapy with
some other anticancer agents. For example, the cytotoxic
activity of the cyclin-dependent kinase inhibitor,
flavopiridol, has been used with other anticancer agents in
10 cancer combination therapy. (Cancer Research, 57, 3375
(1997)).

Also, it has recently been disclosed that cdk
inhibitors may be useful in the chemoprevention of cancer.
Chemoprevention is defined as inhibiting the development of
15 invasive cancer by either blocking the initiating mutagenic
event or by blocking the progression of pre-malignant cells
that have already suffered an insult or inhibiting tumor
relapse (U.S. Patent No. 6,107,305).

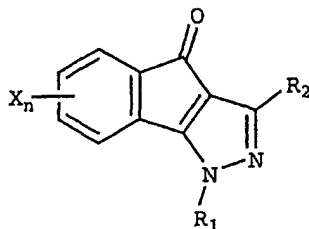
It has recently been discovered that cdk5 is involved
20 in the phosphorylation of tau protein, and therefore cdk
inhibitors may be useful in the treatment of Alzheimer's
disease (J. Biochem., 117, 741-749, 1995).
This body of evidence has led to an intense search for small
molecule inhibitors of the cdk family as an approach to
25 cancer chemotherapy.

A series of indeno[1,2-c]pyrazoles having anticancer
activity are described in JP 60130521 and JP 62099361 with
the following generic structure:



30

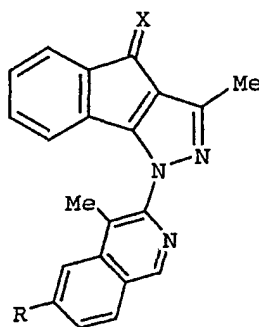
5 A series of indeno[1,2-c]pyrazoles having herbicidal activity are described in GB 2223946 with the following generic structure:



10

A series of 1-(6'-substituted-4'-methylquinol-2'-yl)-3-methylindeno[1,2-c]pyrazoles having CNS activity are described by Quraishi, Farmaco 44:753-8, 1989 with the following generic structure:

15



There remains a strong unmet need for new cdk inhibitors for use in treating proliferative diseases associated with cdk activity.

20

SUMMARY OF THE INVENTION

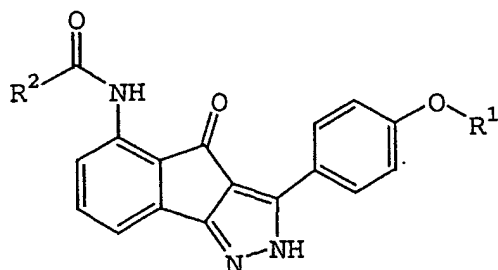
The present invention describes a novel class of 5-substituted-3-(4-OR¹-phenyl)-2H-indeno[1,2-c]pyrazol-4-ones or pharmaceutically acceptable salt forms thereof that are

25 potent inhibitors of the class of enzymes known as cyclin

5 dependent kinases, which relate to the catalytic subunits cdk 1-9 and their regulatory subunits know as cyclins A-H.

The present invention is directed to compounds of formula (I), or pharmaceutically acceptable salts thereof, which act as cyclin dependent kinase inhibitors:

10



(I)

15 wherein :

R¹ is selected from the group consisting of -H and -C₁-4alkyl;

R² is selected from the group consisting of -C₁-4alkoxy, -NR³R⁴, and -(CH₂)NR³R⁴;

20 R³ is selected from the group consisting of -H and morpholino;

R⁴ is selected from the group consisting of -H and cyclohexyl

substituted with -NH₂; alternatively, R³ and R⁴ together
25 form a 6-membered heterocycle containing 1 to 2 heteroatoms selected from nitrogen and oxygen wherein said 6-membered heterocycle is substituted with 1 R⁵; and

R⁵ is selected from the group consisting of -H, -NH₂, -CH₂NH₂, and -CH₂CH₂NH₂.

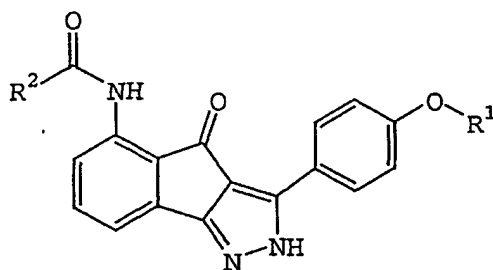
5 The present invention is also directed to a novel
method of treating proliferative diseases associated with
CDK activity by administering a therapeutically effective
amount of one of the compounds of the present invention or a
pharmaceutically acceptable salt form thereof to a patient
10 in need of such therapy.

The present invention also relates to a novel method of
treating cancer associated with CDK activity by
administering a therapeutically effective amount of one of
the compounds of the invention or a pharmaceutically
15 acceptable salt form thereof.

A novel method of treating a proliferative disease,
which comprises administering a therapeutically effective
combination of one of the compounds of the present invention
in combination with one or more other known anti-cancer
20 treatments such as radiation therapy, chemotoxic or
chemostatic agents is also disclosed.

DETAILED DESCRIPTION OF THE INVENTION

Compounds of the present invention have formula (I), or
25 pharmaceutically acceptable salts thereof, which act as
cyclin dependent kinase inhibitors:



30

(I)

wherein :

- 5 R¹ is selected from the group consisting of -H and -C₁-
4alkyl;
- R² is selected from the group consisting of -C₁-4alkoxy,
-NR³R⁴, and -(CH₂)NR³R⁴;
- R³ is selected from the group consisting of -H and
10 morpholino;
- R⁴ is selected from the group consisting of -H and
cyclohexyl
substituted with -NH₂; alternatively, R³ and R⁴ together
form a 6-membered heterocycle containing 1 to 2 heteroatoms
15 selected from nitrogen and oxygen wherein said 6-membered
heterocycle is substituted with 1 R⁵; and
R⁵ is selected from the group consisting of -H, -NH₂,
-CH₂NH₂, and -CH₂CH₂NH₂.

As used above, and throughout the description of the
20 invention, the following terms, unless otherwise indicated,
shall be understood to have the following meaning.
The term "compounds of the invention", and equivalent
expressions, are meant to embrace compounds of formula (I),
and includes prodrugs, pharmaceutically acceptable salts,
25 and solvates, e.g. hydrates. Similarly, reference to
intermediates, whether or not they themselves are claimed,
is meant to embrace their salts, and solvates, where the
context so permits.

The term "derivative" means a chemically modified
30 compound wherein the modification is considered routine by
the ordinary skilled chemist, such as an ester or an amide
of an acid, protecting groups, such as a benzyl group for an
alcohol or thiol, and tert-butoxycarbonyl group for an
amine.

5 The term "analogue" means a compound which comprises a chemically modified form of a specific compound or class thereof, and which maintains the pharmaceutical and/or pharmacological activities characteristic of said compound or class.

10 The term "solvate" means a physical association of a compound of this invention with one or more solvent molecules. This physical association includes hydrogen bonding. In certain instances the solvate will be capable of isolation, for example when one or more solvent molecules
15 are incorporated in the crystal lattice of the crystalline solid. "Solvate" encompasses both solution-phase and isolable solvates. Exemplary solvates include hydrates, ethanولات, methanولات, and the like.

 The term "effective amount" means an amount of a
20 compound/composition according to the present invention effective in producing the desired therapeutic effect. The term "patient" includes both human and other mammals. The term "pharmaceutical composition" means a composition comprising a compound of formula (I) in combination with at
25 least one additional pharmaceutical adjuvant, excipient, vehicle and/or carrier component pharmaceutically acceptable, such as diluents, preserving agents, fillers, flow regulating agents, disintegrating agents, wetting agents, emulsifying agents, suspending agents, sweetening
30 agents, flavoring agents, perfuming agents, antibacterial agents, antifungal agents, lubricating agents and dispensing agents, depending on the nature of the mode of administration and dosage forms. Any ingredient listed in Remington's Pharmaceutical Sciences, 18th ed., Mack
35 Publishing Company, may be used.

5 The term "alkyl" is intended to include both branched and straight-chain saturated aliphatic hydrocarbon groups having the specified number of carbon atoms. Examples of alkyl include, but are not limited to, methyl, ethyl, n-propyl, i-propyl, n-butyl, s-butyl, and t-butyl.

10 The term "alkoxy" is intended to represent an alkyl group with the indicated number of carbon atoms attached to an oxygen atom. Examples of alkoxy include, but are not limited to, methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, s-butoxy, and t-butoxy.

15 As used herein, the term "heterocycle" or "heterocyclic system" means a cyclic compound which consists of carbon atoms and from 1 to 2 heteroatoms independently selected from the group consisting of nitrogen and oxygen atoms. The nitrogen atom may optionally be oxidized. The heterocyclic
20 ring may be attached to its pendant group at any heteroatom or carbon atom which results in a stable structure. The heterocyclic rings described herein may be substituted on carbon or on a nitrogen atom if the resulting compound is stable. If specifically noted, a nitrogen in the
25 heterocycle may optionally be quaternized.

Examples of heterocycles include, but are not limited to piperidinyl, morpholinyl, or piperazinyl groups.

As used herein, "pharmaceutically acceptable salts" refer to derivatives of the disclosed compounds wherein the
30 parent compound is modified by making acid or base salts thereof. Examples of pharmaceutically acceptable salts include, but are not limited to, mineral or organic acid salts of basic residues such as amines; alkali or organic salts of acidic residues such as carboxylic acids; and the
35 like. The pharmaceutically acceptable salts include the conventional non-toxic salts or the quaternary ammonium

5 salts of the parent compound formed, for example, from non-toxic inorganic or organic acids. For example, such conventional non-toxic salts include those derived from inorganic acids such as hydrochloric, hydrobromic, sulfuric, sulfamic, phosphoric, nitric and the like; and the salts
10 prepared from organic acids such as acetic, propionic, succinic, glycolic, stearic, lactic, malic, tartaric, citric, ascorbic, pantoic, maleic, hydroxymaleic, phenylacetic, glutamic, benzoic, salicylic, sulfanilic, 2-acetoxybenzoic, fumaric, toluenesulfonic, methanesulfonic,
15 ethane disulfonic, oxalic, isethionic, and the like.

The pharmaceutically acceptable salts of the present invention can be synthesized from the parent compound which contains a basic or acidic moiety by conventional chemical methods. Generally, such salts can be prepared by reacting
20 the free acid or base forms of these compounds with a stoichiometric amount of the appropriate base or acid in water or in an organic solvent, or in a mixture of the two; generally, nonaqueous media like ether, ethyl acetate, ethanol, isopropanol, or acetonitrile are preferred. Lists
25 of suitable salts are found in Remington's Pharmaceutical Sciences, 18th ed., Mack Publishing Company, Easton, PA, 1990, p. 1445, the disclosure of which is hereby incorporated by reference.

The compounds of the present invention are useful in
30 the form of the free base or acid or in the form of a pharmaceutically acceptable salt thereof. All forms are within the scope of the invention.

The phrase "pharmaceutically acceptable" is employed herein to refer to those compounds, materials, compositions,
35 and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the

5 tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication commensurate with a reasonable risk/benefit ratio.

The term "pharmaceutically acceptable prodrugs" as used
10 herein means those prodrugs of the compounds useful according to the present invention which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of humans and lower animals without undue toxicity, irritation, allergic response, and the like,
15 commensurate with a reasonable risk/benefit ratio, and effective for their intended use, as well as zwitterionic forms, where possible, of the compounds of the invention.

The term "prodrugs", as the term is used herein, are intended to include any covalently bonded carriers which
20 release an active parent drug of the present invention in vivo when such prodrug is administered to a mammalian subject. Since prodrugs are known to enhance numerous desirable qualities of pharmaceuticals (i.e., solubility, bioavailability, manufacturing, etc.) the compounds of the
25 present invention may be delivered in prodrug form. Thus, the skilled artisan will appreciate that the present mention encompasses prodrugs of the presently claimed compounds, methods of delivering the same, and compositions containing the same. Prodrugs of the present invention are prepared by
30 modifying functional groups present in the compound in such a way that the modifications are cleaved, either in routine manipulation or in vivo, to the parent compound. The transformation in vivo may be, for example, as the result of some metabolic process, such as chemical or enzymatic
35 hydrolysis of a carboxylic, phosphoric or sulphate ester, or reduction or oxidation of a susceptible functionality.

5 Prodrugs include compounds of the present invention wherein a hydroxy, amino, or sulfhydryl group is bonded to any group that, when the prodrug of the present invention is administered to a mammalian subject, it cleaves to form a free hydroxyl, free amino, or free sulfhydryl group, respectively. Functional groups which may be rapidly transformed, by metabolic cleavage, in vivo form a class of groups reactive with the carboxyl group of the compounds of this invention. They include, but are not limited to such groups as alkanoyl (such as acetyl, propionyl, butyryl, and the like), unsubstituted and substituted aroyl (such as benzoyl and substituted benzoyl), alkoxycarbonyl (such as ethoxycarbonyl), trialkylsilyl (such as trimethyl- and triethysilyl), monoesters formed with dicarboxylic acids (such as succinyl), and the like. Because of the ease with which the metabolically cleavable groups of the compounds useful according to this invention are cleaved in vivo, the compounds bearing such groups can act as pro-drugs. The compounds bearing the metabolically cleavable groups have the advantage that they may exhibit improved bioavailability as a result of enhanced solubility and/or rate of absorption conferred upon the parent compound by virtue of the presence of the metabolically cleavable group. A thorough discussion of prodrugs is provided in the following: Design of Prodrugs, H. Bundgaard, ed., Elsevier, 1985; Methods in Enzymology, K. Widder et al, Ed., Academic Press, 42, p.309-396, 1985; A Textbook of Drug Design and Development, Krogsgaard-Larsen and H. Bundgaard, ed., Chapter 5; "Design and Applications of Prodrugs" p.113-191; 1991; Advanced Drug Delivery Reviews, H. Bundgard, 8, p.1-38, 1992; Journal of Pharmaceutical Sciences, 77, p. 285, 1988; Chem. Pharm. Bull., N. Nakeya et al, 32, p. 692, 1984; Pro-drugs as

5 Novel Delivery Systems, T. Higuchi and V. Stella, Vol. 14 of
the A.C.S. Symposium Series, and Bioreversible Carriers in
Drug Design, Edward B. Roche, ed., American Pharmaceutical
Association and Pergamon Press, 1987, each of which is
herein incorporated by reference in their entirety as though
10 set forth in full.

The term "treating" refers to: (i) preventing a
disease, disorder or condition from occurring in an animal
which may be predisposed to the disease, disorder and/or
condition but has not yet been diagnosed as having it; (ii)
15 inhibiting the disease, disorder or condition, i.e.,
arresting its development; and (iii) relieving the disease,
disorder or condition, i.e., causing regression of the
disease, disorder and/or condition.

20 Preparation of Compounds of the Invention

It will be apparent to those skilled in the art that
certain compounds of formula (I) can exhibit isomerism, for
example geometrical isomerism, e.g., E or Z isomerism, and
25 optical isomerism, e.g., R or S configurations. Geometrical
isomers include the cis and trans forms of compounds of the
invention having alkenyl moieties. It is well known in the
art how to prepare optically active forms, such as by
resolution of racemic forms or by synthesis from optically
30 active starting materials. All chiral, diastereomeric,
racemic forms and all geometric isomeric forms of a
structure are intended, unless the specific stereochemistry
or isomer form is specifically indicated.

Such isomers can be separated from their mixtures, by
35 the application or adaptation of known methods, for example
chromatographic techniques and recrystallization techniques,

5 or they are separately prepared from the appropriate isomers of their intermediates, for example by the application or adaptation of methods described herein.

Where the compound of the present invention is substituted with a basic moiety, acid addition salts are
10 formed and are simply a more convenient form for use; and in practice, use of the salt form inherently amounts to use of the free base form. The acids which can be used to prepare the acid addition salts include preferably those which
15 acceptable salts, that is, salts whose anions are non-toxic to the patient in pharmaceutical doses of the salts, so that the beneficial inhibitory effects on CDK inherent in the free base are not vitiated by side effects ascribable to the anions. Although pharmaceutically acceptable salts of said
20 basic compounds are preferred, all acid addition salts are useful as sources of the free base form even if the particular salt, per se, is desired only as an intermediate product as, for example, when the salt is formed only for purposes of purification, and identification, or when it is
25 used as an intermediate in preparing a pharmaceutically acceptable salt by ion exchange procedures.

According to a further feature of the invention, acid addition salts of the compounds of this invention are prepared by reaction of the free base with the appropriate
30 acid, by the application or adaptation of known methods. For example, the acid addition salts of the compounds of this invention are prepared either by dissolving the free base in aqueous or aqueous-alcohol solution or other suitable solvents containing the appropriate acid and
35 isolating the salt by evaporating the solution, or by reacting the free base and acid in an organic solvent, in

5 which case the salt separates directly or can be obtained by concentration of the solution.

The acid addition salts of the compounds of this invention can be regenerated from the salts by the application or adaptation of known methods. For example,
10 parent compounds of the invention can be regenerated from their acid addition salts by treatment with an alkali, e.g. aqueous sodium bicarbonate solution or aqueous ammonia solution.

Where the compound of the invention is substituted with
15 an acidic moiety, base addition salts may be formed and can be simply a more convenient form for use; and in practice, use of the salt form can inherently amounts to use of the free acid form. The bases which can be used to prepare the base addition salts include those which produce, when
20 combined with the free acid, pharmaceutically acceptable salts, that is, salts whose cations are non-toxic to the animal organism in pharmaceutical doses of the salts, so that the beneficial inhibitory effects on CDK inherent in the free acid are not vitiated by side effects ascribable to
25 the cations. Pharmaceutically acceptable salts, including for example alkali and alkaline earth metal salts, within the scope of the invention are those derived from the following bases: sodium hydride, sodium hydroxide, potassium hydroxide, calcium hydroxide, aluminum hydroxide, lithium
30 hydroxide, magnesium hydroxide, zinc hydroxide, ammonia, ethylenediamine, N-methyl-glucamine, lysine, arginine, ornithine, choline, N,N'-dibenzylethylenediamine, chloroprocaine, diethanolamine, procaine, N-benzylphenethylamine, diethylamine, piperazine,
35 tris(hydroxymethyl)-aminomethane, tetramethylammonium hydroxide, and the like.

5 Metal salts of compounds of the present invention may
be obtained by contacting a hydride, hydroxide, carbonate or
similar reactive compound of the chosen metal in an aqueous
or organic solvent with the free acid form of the compound.
The aqueous solvent employed may be water or it may be a
10 mixture of water with an organic solvent, preferably an
alcohol such as methanol or ethanol, a ketone such as
acetone, an aliphatic ether such as tetrahydrofuran, or an
ester such as ethyl acetate. Such reactions are normally
conducted at ambient temperature but they may, if desired,
15 be conducted with heating.

Amine salts of compounds of the present invention may
be obtained by contacting an amine in an aqueous or organic
solvent with the free acid form of the compound. Suitable
aqueous solvents include water and mixtures of water with
20 alcohols such as methanol or ethanol, ethers such as
tetrahydrofuran, nitriles such as acetonitrile, or ketones
such as acetone. Amino acid salts may be similarly
prepared.

The base addition salts of the compounds of this
25 invention can be regenerated from the salts by the
application or adaptation of known methods. For example,
parent compounds of the invention can be regenerated from
their base addition salts by treatment with an acid, e.g.
hydrochloric acid.

30 Pharmaceutically acceptable salts also include
quaternary lower alkyl ammonium salts. The quaternary salts
are prepared by the exhaustive alkylation of basic nitrogen
atoms in compounds, including nonaromatic and aromatic basic
nitrogen atoms, according to the invention, i.e., alkylating
35 the non-bonded pair of electrons of the nitrogen moieties
with an alkylating agent such as methylhalide, particularly

5 methyl iodide, or dimethyl sulfate. Quaternarization results in the nitrogen moiety becoming positively charged and having a negative counter ion associated therewith.

As will be self-evident to those skilled in the art, some of the compounds of this invention do not form stable
10 salts. However, acid addition salts are more likely to be formed by compounds of this invention having a nitrogen-containing heteroaryl group and/or wherein the compounds contain an amino group as a substituent. Preferable acid addition salts of the compounds of the invention are those
15 wherein there is not an acid labile group.

As well as being useful in themselves as active compounds, salts of compounds of the invention are useful for the purposes of purification of the compounds, for example by exploitation of the solubility differences
20 between the salts and the parent compounds, side products and/or starting materials, by techniques well known to those skilled in the art.

Compounds according to the invention, for example, starting materials, intermediates or products, are prepared
25 as described herein or by the application or adaptation of known methods, by which is meant methods used heretofore or described in the literature, for example those described by R. C. Larock in Comprehensive Organic Transformations, VCH publishers, 1989.

30 In the reactions described hereinafter it may be necessary to protect reactive functional groups, for example hydroxy, amino, imino, thio or carboxy groups, where these are desired in the final product, to avoid their unwanted participation in the reactions. Conventional protecting
35 groups may be used in accordance with standard practice, for examples see T.W. Green and P.G.M. Wuts in "Protective Groups

5 in Organic Chemistry" John Wiley and Sons, 1991; J. F. W. McOmie in "Protective Groups in Organic Chemistry" Plenum Press, 1973.

The compounds useful according to the invention optionally are supplied as salts. Those salts which are
10 pharmaceutically acceptable are of particular interest since they are useful in administering the foregoing compounds for medical purposes. Salts which are not pharmaceutically acceptable are useful in manufacturing processes, for isolation and purification purposes, and in some instances,
15 for use in separating stereoisomeric forms of the compounds of this invention. The latter is particularly true of amine salts prepared from optically active amines.

Where the compound useful according to the invention contains a carboxy group, or a sufficiently acidic
20 bioisostere, base addition salts may be formed and are simply a more convenient form for use; and in practice, use of the salt form inherently amounts to use of the free acid form.

Also, where the compound useful according to the
25 invention contains a basic group, or a sufficiently basic bioisostere, acid addition salts may be formed and are simply a more convenient form for use; and in practice, use of the salt form inherently amounts to use of the free base form.

30 The foregoing compounds useful according to the invention may also be combined with another therapeutic compound to form pharmaceutical compositions (with or without diluent or carrier) which, when administered, provide simultaneous administration of two or more active
35 ingredients resulting in the combination therapy of the invention.

5 While it is possible for compounds useful according to
the invention to be administered alone it is preferably to
present them as pharmaceutical compositions. The
pharmaceutical compositions, both for veterinary and for
human use, useful according to the present invention
10 comprise at least one compound of the invention, as above
defined, together with one or more acceptable carriers
therefor and optionally other therapeutic ingredients. The
skilled artisan will appreciate the abundance of
publications setting forth the state of the art for
15 pharmaceutical administration.

Examples of suspending agents include ethoxylated
isostearyl alcohols, polyoxyethylene sorbitol and sorbitan
esters, microcrystalline cellulose, aluminum metahydroxide,
bentonite, agar-agar and tragacanth, or mixtures of these
20 substances. Prevention of the action of microorganisms can
be ensured by various antibacterial and antifungal agents,
for example, parabens, chlorobutanol, phenol, sorbic acid,
and the like. It may also be desirable to include isotonic
agents, for example sugars, sodium chloride and the like.
25 Prolonged absorption of the injectable pharmaceutical form
can be brought about by the use of agents delaying
absorption, for example, aluminum monostearate and gelatin.
Examples of suitable carriers, diluents, solvents or
vehicles include water, ethanol, polyols, suitable mixtures
30 thereof, vegetable oils (such as olive oil) and injectable
organic esters such as ethyl oleate. Examples of excipients
include lactose, milk sugar, sodium citrate, calcium
carbonate, dicalcium phosphate phosphate. Examples of
disintegrating agents include starch, alginic acids and
35 certain complex silicates. Examples of lubricants include

5 magnesium stearate, sodium lauryl sulphate, talc, as well as high molecular weight polyethylene glycols.

In certain preferred embodiments, active ingredients necessary in combination therapy may be combined in a single pharmaceutical composition for simultaneous administration.

10 The choice of vehicle and the content of active substance in the vehicle are generally determined in accordance with the solubility and chemical properties of the active compound, the particular mode of administration and the provisions to be observed in pharmaceutical
15 practice. For example, excipients such as lactose, sodium citrate, calcium carbonate, dicalcium phosphate and disintegrating agents such as starch, alginic acids and certain complex silicates combined with lubricants such as magnesium stearate, sodium lauryl sulphate and talc may be
20 used for preparing tablets. To prepare a capsule, it is advantageous to use lactose and high molecular weight polyethylene glycols. When aqueous suspensions are used they can contain emulsifying agents or agents which facilitate suspension. Diluents such as sucrose, ethanol,
25 polyethylene glycol, propylene glycol, glycerol and chloroform or mixtures thereof may also be used.

The oily phase of the emulsions of this invention may be constituted from known ingredients in a known manner. While the oily phase may comprise merely an emulsifier
30 (otherwise known as an emulgent), it desirably comprises a mixture of at least one emulsifier with a fat or an oil or with both a fat and an oil. Preferably, a hydrophilic emulsifier is included together with a lipophilic emulsifier which acts as a stabilizer. It is also preferred to include
35 both an oil and a fat. Together, the emulsifier(s) with or without stabilizer(s) make up the emulsifying wax, and the

5 way together with the oil and fat make up the emulsifying
ointment base which forms the oily dispersed phase of a
cream formulation. Emulgents and emulsion stabilizers
suitable for use in the formulation of the present invention
include Tween® 60, Span® 80, cetostearyl alcohol, benzyl
10 alcohol, myristyl alcohol, glyceryl mono-stearate and sodium
lauryl sulfate.

If desired, the aqueous phase of the cream base may
include, for example, a least 30% w/w of a polyhydric
alcohol, i.e. an alcohol having two or more hydroxyl groups
15 such as propylene glycol, butane 1,3-diol, mannitol,
sorbitol, glycerol and polyethylene glycol (including PEG
400) and mixtures thereof. The topical formulations may
desirably include a compound which enhances absorption or
penetration of the active ingredient through the skin or
20 other affected areas. Examples of such dermal penetration
enhancers include dimethyl sulphoxide and related analogues.

The choice of suitable oils or fats for the formulation
is based on achieving the desired cosmetic properties. Thus
the cream should preferably be a non-greasy, non-staining
25 and washable product with suitable consistency to avoid
leakage from tubes or other containers. Straight or
branched chain, mono- or dibasic alkyl esters such as di-
isopropyl myristate, decyl oleate, isopropyl palmitate,
butyl stearate, 2-ethylhexyl palmitate or a blend of
30 branched chain esters known as Crodamol CAP may be used, the
last three being preferred esters. These may be used alone
or in combination depending on the properties required.
Alternatively, high melting point lipids such as white soft
paraffin and/or liquid paraffin or other mineral oils can be
35 used. Solid compositions may also be employed as fillers in
soft and hard-filled gelatin capsules using such excipients

5 as lactose or milk sugar as well as high molecular weight polyethylene glycols, and the like.

The pharmaceutical compositions can be administered in a suitable formulation to humans and animals by topical or systemic administration, including oral, inhalational,
10 rectal, nasal, buccal, sublingual, vaginal, parenteral (including subcutaneous, intramuscular, intravenous, intradermal, intrathecal and epidural), intracisternal and intraperitoneal. It will be appreciated that the preferred route may vary with for example the condition of the
15 recipient.

The formulations can be prepared in unit dosage form by any of the methods well known in the art of pharmacy. Such methods include the step of bringing into association the active ingredient with the carrier which constitutes one or
20 more accessory ingredients. In general the formulations are prepared by uniformly and intimately bringing into association the active ingredient with liquid carriers or finely divided solid carriers or both, and then, if necessary, shaping the product.

25 A tablet may be made by compression or moulding, optionally with one or more accessory ingredients. Compressed tables may be prepared by compressing in a suitable machine the active ingredient in a free-flowing form such as a powder or granules, optionally mixed with a
30 binder, lubricant, inert diluent, preservative, surface active or dispersing agent. Moulded tablets may be made by moulding in a suitable machine a mixture of the powdered compounds moistened with an inert liquid diluent. The tablets may optionally be coated or scored and may be
35 formulated so as to provide slow or controlled release of the active ingredient therein.

5 Solid compositions for rectal administration include suppositories formulated in accordance with known methods and containing at least one compound of the invention.

 If desired, and for more effective distribution, the compounds can be microencapsulated in, or attached to, a
10 slow release or targeted delivery systems such as a biocompatible, biodegradable polymer matrices (e.g. poly(d,l-lactide co-glycolide)), liposomes, and microspheres and subcutaneously or intramuscularly injected by a technique called subcutaneous or intramuscular depot to
15 provide continuous slow release of the compound(s) for a period of 2 weeks or longer. The compounds may be sterilized, for example, by filtration through a bacteria retaining filter, or by incorporating sterilizing agents in the form of sterile solid compositions which can be
20 dissolved in sterile water, or some other sterile injectable medium immediately before use.

 Actual dosage levels of active ingredient in the compositions of the invention may be varied so as to obtain an amount of active ingredient that is effective to obtain a
25 desired therapeutic response for a particular composition and method of administration. The selected dosage level therefore depends upon the desired therapeutic effect, on the route of administration, on the desired duration of treatment and other factors.

30 Total daily dose of the compounds useful according to this invention administered to a host in single or divided doses may be in amounts, for example, of from about 0.0001 to about 100 mg/kg body weight daily and preferably 0.01 to 10 mg/kg/day. Dosage unit compositions may contain such
35 amounts of such submultiples thereof as may be used to make up the daily dose. It will be understood, however, that the

5 specific dose level for any particular patient will depend
upon a variety of factors including the patient's body
weight, general health, sex, diet, time and route of
administration, rates of absorption and excretion,
combination with other drugs and the severity of the
10 particular disease being treated.

The amount of each component administered is determined
by the attending clinicians taking into consideration the
etiology and severity of the disease, the patient's
condition and age, the potency of each component and other
15 factors.

The formulations may be presented in unit-dose or
multi-dose containers, for example sealed ampoules and vials
with elastomeric stoppers, and may be stored in a freeze-
dried (lyophilized) condition requiring only the addition of
20 the sterile liquid carrier, for example water for
injections, immediately prior to use. Extemporaneous
injection solutions and suspensions may be prepared from
sterile powders, granules and tablets of the kind previously
described.

25 Administration of a compound of the present invention
in combination with additional therapeutic agents, may
afford an efficacy advantage over the compounds and agents
alone, and may do so while permitting the use of lower doses
of each. A lower dosage minimizes the potential of side
30 effects, thereby providing an increased margin of safety.
The combination of a compound of the present invention with
such additional therapeutic agents is preferably a
synergistic combination. Synergy, as described for example
by Chou and Talalay, Adv. Enzyme Regul. 22:27-55 (1984),
35 occurs when the therapeutic effect of the compound and agent
when administered in combination is greater than the

5 additive effect of either the compound or agent when
administered alone. In general, a synergistic effect is most
clearly demonstrated at levels that are (therapeutically)
sub-optimal for either the compound of the present invention
or a known anti-proliferative agent alone, but which are
10 highly efficacious in combination. Synergy can be in terms
of improved inhibitory response without substantial
increases in toxicity over individual treatments alone, or
some other beneficial effect of the combination compared
with the individual components.

15 Procedures for evaluating the biological activity of
compounds or compositions according to the invention are
carried out as described herein or by the application or
adaptation of known procedures, by which is meant procedures
used heretofore or as described in the literature.
20 The compounds of the present invention, their methods or
preparation and their biological activity will appear more
clearly from the examination of the following examples which
are presented as an illustration only and are not to be
considered as limiting the invention in its scope. The
25 following examples are but preferred methods of synthesizing
the compounds of the invention, which may be prepared
according to any method known to the organic chemist of
ordinary skill. Other features of the invention will become
apparent during the following descriptions of exemplary
30 embodiments which are given for illustration of the
invention and are not intended to be limiting thereof. Each
of the cited references are hereby incorporated herein by
reference in their entirety as though set forth in full.

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EXAMPLES

The following abbreviations are used throughout the following Examples: "°C" for degrees Celsius, "CIMS" for chemical ionization mass spectroscopy, "eq" for equivalent or equivalents, "g" for gram or grams, "h" for hour or hours, "mg" for milligram or milligrams, "mL" for milliliter or milliliters, "mmol" for millimolar, "M" for molar, "min" for minute or minutes, "p-TsOH" for para-toluenesulphonic acid, "DMF" for dimethylformamide, and "TFA" for trifluoroacetic acid.

15

EXAMPLE 1

Preparation of Intermediate 1

The preparation of intermediate 1, (N-[2-(4-Methoxy-benzoyl)-1,3-dioxo-indan-4-yl]-acetamide) is described in Nugiel, D.A.; Etzkorn, A.M.; Vidwans, A.; Benfield, P.A.; Boisclair, M.; Burton, C.R.; Cox, S.; Czerniak, P.M.; Doleniak, D.; Seitz, S.P. J. Med. Chem. 2001, 44, 1334-1336 which is herein incorporated by reference in it's entirety as though set forth in full.

25

EXAMPLE 2

Preparation of Intermediate 2

Synthesis of 4-Amino-2-(4-methoxy-benzoyl)-indan-1,3-dione: The compound prepared in example 1 (2.0 g, 5.93 mmol) is dissolved in 20% HCl in methanol (50 mL). This solution is stirred at reflux for a period of 3 h. It is then allowed to cool to room temperature and stirred overnight. The product is filtered off, washed with ethanol (20 mL) and air dried to give the product as a yellow solid (1.5 g, 85.7%). mp 268-269 °C; ¹H NMR (DMSO-d₆) δ 8.17 (d, J = 8.8 Hz, 2H),

35

5 7.49 (t, 1H), 7.12 (d, J = 8.7 Hz, 2H), 6.98 (m, 2H), 3.88
(s, 1H).

EXAMPLE 3

Preparation of Intermediate 3

10 Synthesis of [2-(4-Methoxybenzoyl)-1,3-dioxo-indan-4-
yl]-carbamic acid phenyl ester: The product prepared in
Example 2 (1.5 g, 5.08 mmol) is dissolved in acetone (40 mL)
and treated with sodium carbonate (1.26 g, 15.24 mmol) and
phenyl chloroformate (1.19 g, 7.62 mmol). The suspension is
15 stirred at 50 °C for 3 h. The reaction mixture is diluted
with water (120 mL), and extracted with ethyl acetate (2 x
100 mL). The organic layer is separated, washed with brine
(50 mL), dried (Na₂SO₄) and the solvent removed at reduced
pressure to give a gummy orange residue. Cold ethyl ether
20 (100 mL) is added to this residue to give a precipitate. The
precipitate is collected and washed with ethyl ether (2 x 10
mL) to give desired product as a yellow solid (1.65 g, 78%).
mp 256-258 °C; ¹HNMR (DMSO-d₆) δ 10.83 (s, 1H), 8.08 (d, J =
8.0 Hz, 1H), 7.57 (d, J = 2.9 Hz, 2H), 7.54 (m, 3H), 7.28
25 (m, 3H), 7.09 (t, 1H), 6.89 (d, J = 10.8 Hz, 2H), 3.81 (s,
3H).

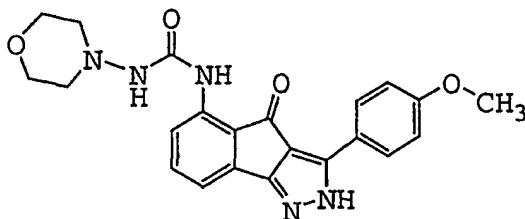
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EXAMPLE 4

Preparation of 1-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-3-morpholin-4-yl-urea



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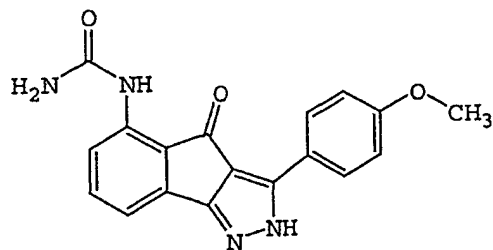
The product prepared in Example 3 (0.03 g, 0.072 mmol) in anhydrous DMSO (2 mL) is treated with 4-aminomorpholine (0.0084g, 0.082 mmol) and 4-dimethylaminopyridine (0.005 g, 0.04 mmol) and heated to 80 °C for 3h. The solvent is removed under reduced pressure and the residue triturated with ethanol to give a dark solid. The solid is collected and washed with ethanol (5 mL) to give a tricarbonyl urea (0.03 g, 100%). The tricarbonyl urea intermediate (0.03 g, 0.078 mmol) is treated with hydrazine hydrate (0.1 mL, 3.21 mmol) and p-toluenesulfonic acid monohydrate (0.01 g, 0.05 mmol) in refluxing ethanol (4 mL) for a period of 3 h. The reaction mixture is cooled to room temperature, the solid collected, washed with cold ethanol (2 x 2 mL), and air dried to give the product as a yellowish solid (0.012 g, 41.3%). mp 290-291 °C; ¹H NMR (DMSO-d₆) δ 8.27 (d, J = 6.8 Hz, 2H), 8.16 (d, J = 8.8 Hz, 2H), 7.42 (m, 1H), 7.12 (m, 3H), 3.81 (s, 3H), 2.90 (s, 4H), 2.70 (s, 4H), HRMS calcd. for C₂₂H₂₂N₅O₄ (M+H⁺) 420.1672; found 420.1688;

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EXAMPLE 5

Preparation of [3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea



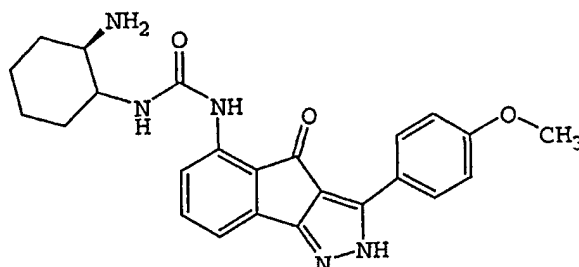
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The product prepared in Example 3 (0.03 g, 0.072 mmol) in anhydrous DMSO (2 mL) is treated with excess ammonium hydroxide solution and 4-dimethylaminopyridine (0.005 g, 0.04 mmol) and is heated to 80 °C for 3h. The solvent is removed under reduced pressure and the residue triturated with ethanol to give a dark solid. The solid is collected and washed with ethanol (5 mL) to give urea (0.03 g, 100%). The tricarboxyl urea intermediate (0.03 g, 0.078 mmol) is treated with hydrazine hydrate (0.1 mL, 3.21 mmol) and p-toluenesulfonic acid monohydrate (0.01 g, 0.05 mmol) in refluxing ethanol (4 mL) for a period of 3 h. The reaction mixture is cooled to room temperature, the solid collected, washed with cold ethanol (2 x 2 mL), and air dried to give the product as a yellowish solid (0.018 g, 62.4%). mp 267-269 °C; ¹H NMR (DMSO-d₆) δ 9.35 (s, 1H), 8.22 (m, 3H), 7.38 (m, 1H), 7.10 (d, J = 8.8 Hz, 2H), 7.02 (d, J = 7 Hz, 1H), 3.81 (s, 3H); HRMS calcd. for C₁₈H₁₅N₄O₃ (M+H⁺) 335.1144; found 335.1162;

30

EXAMPLE 6

Preparation of 1-(2-amino-cyclohexyl)-3-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea

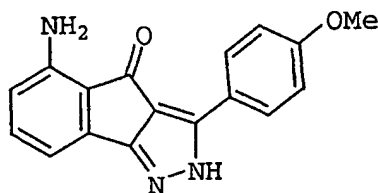


The product prepared in Example 3 (0.03 g, 0.072 mmol) in anhydrous DMSO (2 mL) is treated with 1,2-diaminocyclohexane (0.01g, 0.082 mmol) and 4-dimethylaminopyridine (0.005 g, 0.04 mmol) and heated to 80 °C for 3h. The solvent is removed under reduced pressure and the residue triturated with ethanol to give a dark solid. The solid is collected and washed with ethanol (5 mL) to give a tricarbonyl urea (0.03 g, 100%). The tricarbonyl urea intermediate (0.03 g, 0.078 mmol) is treated with hydrazine hydrate (0.1 mL, 3.21 mmol) and p-toluenesulfonic acid monohydrate (0.01 g, 0.05 mmol) in refluxing ethanol (4 mL) for a period of 3 h. The reaction mixture is cooled to room temperature, the solid collected, washed with cold ethanol (2 x 2 mL), and air dried to give the product as a yellowish solid (0.01 g, 30.6%). ¹HNMR (DMSO-d₆) δ 9.56 (s, 1H), 8.27 (d, 1H), 8.19 (d, 2H), 7.41 (t, 1H), 7.10 (m, 3H), 4.10 (s, 1H), 3.81 (s, 3H), 3.23 (s, 1H), 1.63 (m, 5H), 1.40 (m, 3H).

5

EXAMPLE 7

Preparation of 5-Amino-3-(4-methoxyphenyl)-2-phenyl-2H-indeno-[1,2-c]pyrazol-4-one:



10

A suspension of N-[3-(4-Methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-acetamide (as produced according to Nugiel, D.A.; Etzkorn, A.M.; Vidwans, A.; Benfield, P.A.; Boisclair, M.; Burton, C.R.; Cox, S.; Czerniak, P.M.; Doleniak, D.; Seitz, S.P. J. Med. Chem. 2001, 44, 1334-1336) (1.0 g, 3.0 mmol) in MeOH (10 mL) was treated with concentrated HCl (1 mL) and heated to reflux. After stirring the mixture for 2 h the reaction was cooled and the product was collected by filtration and obtained as a greenish solid (0.7 g, 81%). mp 273 °C; NMR (DMSO-d₆) δ 13.6 (bs, 1 H), 8.3 (d, J = 8.4 Hz, 1 H), 8.1 (d, J = 8.8 Hz, 2 H), 7.5 (t, J = 7.7 Hz 1 H), 7.2 (d, J = 7.0 Hz, 1 H), 7.1 (d, J = 8.8 Hz, 2 H), 3.8 (s, 3 H); HRMS m/e calc'd for C₁₇H₁₄N₂O₂ (M + H): 292.1086, found: 292.1080.

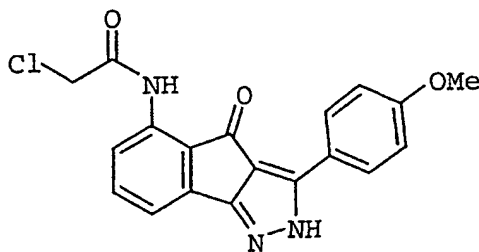
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EXAMPLE 8

Preparation of 2-Chloro-N-[3-(4-methoxyphenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-acetamide:



10

A suspension of the product prepared in Example 7 (0.2 g, 0.7 mmol) in dioxane (10 mL) was treated with aqueous saturated NaHCO_3 (3 mL) and chloroacetyl chloride (3 mL, 0.21 mmol). The reaction was heated to 50°C and stirred for 2 h. The reaction is then cooled, poured into water (20 mL), extracted with EtOAc (100 mL), the organic layer separated, dried (MgSO_4) and the solvent removed at reduced pressure. The residue is recrystallized from EtOH to give the product as a yellow solid (0.09 g, 35%). mp $>300^\circ\text{C}$; NMR ($\text{DMSO}-d_6$) δ 13.6 (bs, 1 H), 11.3 (s, 1 H), 8.3 (d, $J = 8.4$ Hz, 1 H), 8.1 (d, $J = 8.8$ Hz, 2 H), 7.5 (t, $J = 7.7$ Hz, 1 H), 7.2 (d, $J = 7.0$ Hz, 1 H), 7.1 (d, $J = 8.8$ Hz, 2 H), 4.5 (s, 2 H), 3.8 (s, 3 H); HRMS m/e calc'd for $\text{C}_{19}\text{H}_{15}\text{N}_3\text{O}_3\text{Cl}$ ($M + H$): 368.0802, found: 368.0818.

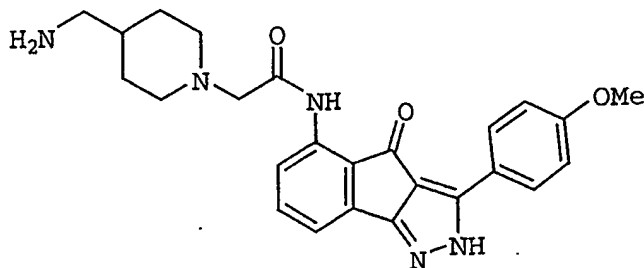
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EXAMPLE 9

Preparation of 2-(4-aminomethyl-piperidin-1-yl)-N-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-acetamide



10

A suspension of product prepared according to Example 8 (0.015 g, 0.04 mmol) in EtOH (1 mL) is treated with 4-aminomethylpiperdine (0.75 mL), placed in a sealed tube and heated to 80 °C for 3 h. The reaction is cooled and the solvent removed at reduced pressure. The residue is recrystallized from EtOH to give the product as a yellow solid (0.009 g, 62%). mp >300 °C; NMR (DMSO-d₆) δ 13.6 (bs, 1 H), 11.3 (s, 1 H), 8.35 (d, J = 8.4 Hz, 1 H), 8.1 (d, J = 8.8 Hz, 2 H), 7.5 (t, J = 7.7 Hz 1 H), 7.2 (d, J = 7.0 Hz, 1 H), 7.1 (d, J = 8.8 Hz, 2 H), 3.8 (s, 3 H), 3.2 (bs, 2 H), 2.9 (bs, 2 H), 2.5 (d, J = 8.0 Hz, 2 H), 2.2 (t, J = 8.0 Hz, 2 H), 1.6 (m, 5 H); HRMS m/e calc'd for C₂₅H₂₈N₅O₃ (M + H): 446.2192, found: 446.2169; Anal. (C₂₅H₂₇N₅O₃) C, H, N.

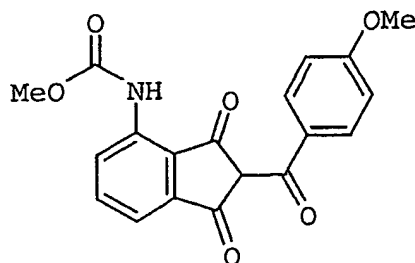
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EXAMPLE 10

Preparation of 2-(4-Methoxybenzoyl)-3-methoxycarbonylamino-indan-1,3-dione:

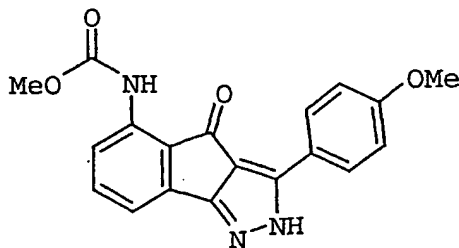


10 A solution of 3-methoxycarbonylamino-phthalic acid dimethyl ester (1 g, 4.8 mmol) and 4-methoxyacetophenone (0.72 g, 4.8 mmol) in dry DMF (3 mL) was heated to 90 °C. Sodium hydride (0.21 g, 60% suspension in oil, 5.2 mmol) is added in one portion and the exothermic reaction turns deep
15 red. After 20 min, the reaction is cooled to room temperature, diluted with water (25 mL) extracted with EtOAc (10 mL) and the aqueous phase separated. The aqueous phase is acidified to pH 2 with 2N HCl and the crude product collected. Recrystallization with ethanol gives the desired
20 product as a yellow solid (0.4 g, 30%). ESIMS 352 (M - H, 100%).

EXAMPLE 11

Preparation of 3-(4-Methoxyphenyl)-5-methoxycarbonylamino-2H-indeno-[1,2-c]pyrazol-4-one:

25



5 A solution of 2-(4-methoxybenzoyl)-3-methoxycarbonylamino-indan-1,3-dione (0.2 g, 0.6 mmol) in EtOH (5 mL) is treated with hydrazine hydrate (0.1 mL, 1.8 mmol) and p-TsOH (3 mg). The reaction is heated to reflux and stirred for 2 h. The reaction is cooled to room
10 temperature and the product crystallized from the reaction mixture. The product is collected by filtration as a yellow solid (0.1 g, 50%). mp >300 °C; HRMS m/e calc'd for C₁₉H₁₆N₂O₄ (M + H): 350.1141, found: 350.1168.

15 UTILITY

Inhibition of Kinase/Cyclin Complex Enzymatic Activity

Several of the compounds disclosed in this invention were assayed for their inhibitory activity against cdk4/D1 and cdk2/E kinase complexes. The in vitro assays employ cell lysates from insect cells expressing either of the kinases and subsequently their corresponding regulatory units. The cdk2/cyclin E is purified from insect cells expressing His-tagged cdk2 and cyclin E. The cdk/cyclin lysate is combined in a microtitre-type plate along with a kinase compatible buffer, ^{32}P -labeled ATP at a concentration of 50 mM, a GST-Rb fusion protein and the test compound at varying concentrations. The kinase reaction is allowed to proceed with the radiolabeled ATP, then effectively stopped by the addition of a large excess of EDTA and unlabeled ATP. The GST-Rb labeled protein is sequestered on a GSH-Sepharose bead suspension, washed, resuspended in scintillant, and the ^{32}P activity detected in a scintillation counter. The compound concentration which inhibits 50% of the kinase activity was calculated for each compound. A compound was considered active if its IC_{50} was found to be less than 1 μM .

5

Inhibition of HCT 116 Cancer Cell Proliferation

To test the cellular activity of several compounds disclosed in this invention, we examined the effect of these compounds on cultured HCT116 cells and determined their effect on cell-cycle progression by the colorimetric cytotoxicity test using sulforhodamine B (Skehan et al. J. Natl. Cancer Inst. 82:1107-12, 1990). Briefly, HCT116 cells are cultured in the presence of test compounds at increasing concentrations. At selected time points, groups of cells are fixed with trichloroacetic acid and stained with sulforhodamine B (SRB). Unbound dye was removed by washing and protein-bound dye was extracted for determination of optical density. A compound was considered active if its IC₅₀ was found to be less than 10 μ M.

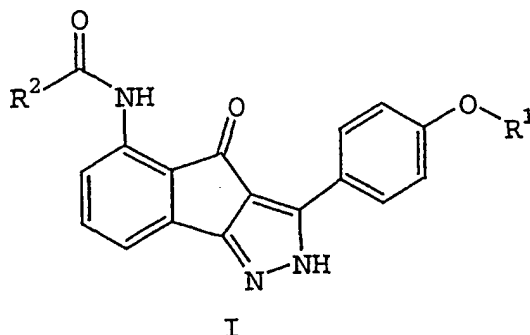
All patents, patent applications and other publications are herein incorporated by reference in their entirety as though set forth in full.

The scope of the following claims is intended to encompass all obvious changes in the details, materials and synthesis that will occur to one of ordinary skill in the art.

5 CLAIMS

What is claimed is:

1. A compound of formula (I):



10

stereoisomers thereof, N-oxides thereof, pharmaceutically acceptable salts thereof, or prodrugs thereof, wherein:

- 15 R^1 is selected from the group consisting of -H and -C₁-C₄ alkyl;
 R^2 is selected from the group consisting of -C₁-C₄ alkoxy, -NR³R⁴, and -(CH₂)NR³R⁴;
 R^3 is selected from the group consisting of -H and morpholino;
 20 R^4 is selected from the group consisting of -H and cyclohexyl
 substituted with -NH₂; alternatively, R^3 and R^4 together form a 6-membered heterocycle containing 1 to 2 heteroatoms
 25 selected from nitrogen and oxygen wherein said 6-membered heterocycle is optionally substituted with 1 R^5 ; and
 R^5 is selected from the group consisting of -H, -NH₂, -CH₂NH₂, and -CH₂CH₂NH₂.

5 2. A compound of Claim 1, wherein:

R^1 is selected from the group consisting of H, methyl, ethyl, and propyl;

R^2 is selected from the group consisting of C₁-C₄ alkoxy, -NR³R⁴, or -(CH₂)NR³R⁴;

10 R^3 is selected from the group consisting of H and morpholino;

R^4 is selected from the group consisting of H or cyclohexyl substituted with -NH₂; alternatively, R^3 and R^4 together form a 6-membered heterocycle containing 1 to 2 heteroatoms

15 selected from nitrogen and oxygen wherein said 6-membered heterocycle is substituted with 1 R^5 ; and

R^5 is selected from the group consisting of -CH₂NH₂ and -CH₂CH₂NH₂.

20 3. A compound of Claim 1, wherein:

R^1 is selected from the group consisting of methyl and ethyl;

R^2 is selected from the group consisting of -OCH₃, -OCH₂CH₃, -NR³R⁴, or -(CH₂)NR³R⁴;

25 R^3 is selected from the group consisting of H or morpholino;

R^4 is selected from the group consisting of H or cyclohexyl substituted with -NH₂; and alternatively, R^3 and R^4 together

form a piperidinyl substituted by 1 R^5 ; and,

R^5 is -CH₂NH₂.

30

4. A compound of Claim 1, stereoisomers thereof, N-oxides thereof, pharmaceutically acceptable salts thereof, and prodrugs thereof, selected from:

5

a) 1-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-3-morpholin-4-yl-urea;

b) [3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea;

c) 1-(2-amino-cyclohexyl)-3-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea; and

d) 2-(4-aminomethyl-piperidin-1-yl)-N-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-acetamide.

5. A compound of Claim 1 consisting of 1-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-3-morpholin-4-yl-urea, stereoisomers thereof, N-oxides thereof, pharmaceutically acceptable salts thereof, or prodrugs thereof.

6. A compound of claim 1 consisting of [3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea, stereoisomers thereof, N-oxides thereof, pharmaceutically acceptable salts thereof, or prodrugs thereof.

7. A compound of Claim 1 consisting of 1-(2-amino-cyclohexyl)-3-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-urea, stereoisomers thereof, N-oxides thereof, pharmaceutically acceptable salts thereof, or prodrugs thereof.

8. A compound of Claim 1 consisting of 2-(4-aminomethyl-piperidin-1-yl)-N-[3-(4-methoxy-phenyl)-4-oxo-2,4-dihydro-

5 indeno[1,2-c]pyrazol-5-yl]-acetamide, stereoisomers thereof,
N-oxides thereof, pharmaceutically acceptable salts thereof,
or prodrugs thereof.

9. A compound of Claim 1 consisting [3-(4-methoxy-phenyl)-
10 4-oxo-2,4-dihydro-indeno[1,2-c]pyrazol-5-yl]-carbamic acid
methyl ester, stereoisomers thereof, N-oxides thereof,
pharmaceutically acceptable salts thereof, or prodrugs
thereof.

15 10. A pharmaceutical composition, comprising a
pharmaceutically acceptable carrier together with a compound
according to claim 1 or a pharmaceutically acceptable salt
or prodrug form thereof.

20 11. A pharmaceutical composition comprising a compound of
Formula I according to claim 1 and a pharmaceutically
acceptable excipient.

12. A method of inhibiting cdk activity in a patient in
25 need of such treatment comprising the steps of administering
to said patient a therapeutically effective amount of a
compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/21449

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :C07D 413/02

US CL :544/140

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 544/140

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CAS ONLINE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Database CAS ONLINE on STN, Chem. Abstr., Accession No. 1999:691083, Vol. 131, No. 299444, NUGIEL D. et al., 'Preparation of 5-aminoindeno(1,2-c)pyrazol-4-ones as anti-cancer and anti-proliferative agents', WO 9954308, 1999/10/28, abstract. See RN 247149-05-9.	5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"A" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

06 SEPTEMBER 2002

Date of mailing of the international search report

02 OCT 2002

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

R. W. RAMSUER

Telephone No. (703) 308-1235

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/21449

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-4,6-12
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Please See Extra Sheet.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐

The additional search fees were accompanied by the applicant's protest.

☐

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/21449

BOX I. OBSERVATIONS WHERE CLAIMS WERE FOUND UNSEARCHABLE

2. Where no meaningful search could be carried out, specifically:

In these claims, the numerous variables (e.g. R1, R2, R3, prodrugs thereof, etc.) and their lengthy complex meanings and their voluminous permutations and combinations and the list of divergent named compounds (claims 4 and 6-8), make it virtually impossible to determine the full scope and complete meaning of the claimed subject. As presented, the claimed subject matter cannot be regarded as being a clear and concise description for which protection is sought and as such the listed claims do not comply with the requirements of PCT Article 6. Thus it is impossible to carry out a meaningful (timely) search on same. A search will be made on the first discernable subject matter of claim 5.